

WHAT IS CLAIMED IS:

1. A graphic processing apparatus having a Z-buffer memory storing a Z value representing a depth of a display object when seen from a visual point per pixel and a pixel
5 memory storing color data on each pixel for creating an image of a shadowed three-dimensional object having a shadow produced by obstructing a ray of light from a light source by the three-dimensional object, comprising:

a visual-point coordinate conversion processing
10 section for upon input of graphic data on normal polygons constituting each object including the three-dimensional object and on shadow polygons constituting a shadow volume that defines a shadow space produced by obstructing the lay of light from the light source by the three-dimensional
15 object, converting the graphic data to visual-point coordinates and depth values, and outputting the obtained visual-point coordinates and depth values in a state of being sorted into those of front-facing shadow polygons that face front, those of back-facing shadow polygons that
20 face back when seen from the visual point, and those of the normal polygons; and

a hidden surface removal and shadowing processing section for obtaining a coordinate region that is positioned behind the front-facing shadow polygons and in
25 front of the back-facing shadow polygons when seen from the

visual point based on the visual-point coordinates, the depth values and the Z-buffer memory after hidden surface removal processing by Z-buffer method is performed on the normal polygons, and updating color data on pixels in the pixel memory corresponding to the obtained coordinate region to shadow color data.

2. The graphic processing apparatus as defined in Claim 1, wherein

10 the Z-buffer memory and the pixel memory have a capacity for one line in one display screen, and the visual-point coordinate conversion processing section and the hidden surface removal and shadowing processing section process per line.

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3. The graphic processing apparatus as defined in Claim 1, wherein

if a plurality of the shadow volumes are present, the hidden surface removal and shadowing processing section performs processing concerning the shadow polygons per shadow volume.

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4. A graphic processing apparatus having a Z-buffer memory storing a Z value representing a depth of a display object when seen from a visual point per pixel and a pixel

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memory storing color data on each pixel for creating an image of a shadowed three-dimensional object having shadows produced by obstructing a ray of light from a light source by the three-dimensional object, comprising:

5 a normal polygon conversion section for upon input of graphic data on normal polygons constituting each object including the three-dimensional object, converting the graphic data to visual-point coordinates and depth values;

10 a shadow polygon conversion section for upon input of graphic data on shadow polygons constituting a shadow volume that defines a shadow space produced by obstructing the lay of light from the light source by the three-dimensional object, converting the graphic data to
15 visual-point coordinates and depth values, and outputting the visual-point coordinates and the depth values in a state of being sorted into those of front-facing shadow polygons that face front when seen from a visual point and those of back-facing shadow polygons that face back when
20 seen from the visual point;

 a normal polygon processing section for performing hidden surface removal processing by Z-buffer method on the normal polygons based on the visual-point coordinates and the depth values of the normal polygons and
25 updating color data and a Z value of each pixel in the

pixel memory and the Z-buffer memory based on the processing result;

5 a back-facing shadow polygon processing section for obtaining a coordinate region positioned in front of the back-facing shadow polygons when seen from the visual point based on the visual-point coordinates and the depth values of the back-facing shadow polygons and on the Z values after the hidden surface removal processing is performed;

10 a shadow flag memory for storing a flag value representing a visual-point coordinate positioned in front of the back-facing shadow polygons; and

15 a front-facing shadow polygon processing section for obtaining a coordinate region positioned behind the front-facing shadow polygons and in front of the back-facing shadow polygons when seen from the visual point based on the visual-point coordinates and the depth values of the front-facing shadow polygons and on the Z values after the hidden surface removal processing is performed
20 and on the flag value, and for updating color data on pixels in the pixel memory corresponding to the obtained coordinate region to shadow color data.

5. The graphic processing apparatus as defined in
25 Claim 4, wherein

the Z-buffer memory, the pixel memory, and the shadow flag memory have a capacity for one line in one display screen, and

the normal polygon conversion section, the shadow
5 polygon conversion section, the normal polygon processing section, the back-facing shadow polygon processing section, and the front-facing shadow polygon processing section process per line.

10 6. The graphic processing apparatus as defined in Claim 4, wherein

if a plurality of the shadow volumes are present, the back-facing shadow polygon processing section and the front-facing shadow polygon processing section perform
15 processing concerning the shadow polygons per shadow volume.

7. The graphic processing apparatus as defined in Claim 4, wherein

20 the normal polygon conversion section, the shadow polygon conversion section, the normal polygon processing section, the back-facing shadow polygon processing section, and the front-facing shadow polygon processing section are included in a portable device.

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8. The graphic processing apparatus as defined in Claim 7, wherein

the portable device is connectable to a communication network, and the graphic data is obtained
5 through communications via the communication network.

9. A graphic processing method using a Z-buffer memory storing a Z value representing a depth of a display object when seen from a visual point per pixel and a pixel
10 memory storing color data on each pixel for creating an image of a shadowed three-dimensional object having shadows produced by obstructing a ray of light from a light source by the three-dimensional object, comprising:

converting graphic data on normal polygons
15 constituting each object including the three-dimensional object to visual-point coordinates and depth values;

converting graphic data on shadow polygons constituting a shadow volume that defines a shadow space produced by obstructing the lay of light from the light
20 source by the three-dimensional object to visual-point coordinates and depth values, and sorting the visual-point coordinates and the depth values into those of front-facing shadow polygons that face front when seen from the visual point and those of back-facing shadow polygons that face
25 back when seen from the visual point;

performing hidden surface removal processing by
Z-buffer method on the normal polygons based on the visual-
point coordinates and the depth values of the normal
polygons and updating color data and a Z value of each
5 pixel in the pixel memory and the Z-buffer memory based on
the processing result;

obtaining a coordinate region positioned in front
of the back-facing shadow polygons when seen from the
visual point based on the visual-point coordinates and the
10 depth values of the back-facing shadow polygons and the Z
values after the hidden surface removal processing is
performed;

obtaining a coordinate region positioned behind
the front-facing shadow polygons when seen from the visual
15 point based on the visual-point coordinates and the depth
values of the front-facing shadow polygons and the Z values
after the hidden surface removal processing is performed;
and

updating color data on pixels in the pixel memory
20 corresponding to a coordinate region positioned behind the
front-facing shadow polygons and in front of the back-
facing shadow polygons when seen from the visual point to
shadow color data.

10. A graphic processing program causing a computer
to function as the normal polygon conversion section, the
shadow polygon conversion section, the normal polygon
processing section, the back-facing shadow polygon
5 processing section, and the front-facing shadow polygon
processing section as defined in Claim 4.

11. A program storage medium allowing computer to
read, characterized in that the graphic processing program
10 as defined in Claim 10 is stored.